WHAT IS CLAIMED IS:

1. An objective comprising a plurality of lenses, wherein at least two lenses consist of fluoride crystal material with a cubic lattice structure and wherein said fluoride crystal lenses are (111)-lenses each having a lens axis oriented approximately perpendicular to the {111}-planes or to crystallographic planes that are equivalent to the {111}-planes of the fluoride crystal, wherein an image point in an image plane is formed at a convergence of a bundle of light rays each of which has an azimuth angle $\alpha_R$, an aperture angle $\theta_R$ and an optical path difference $\Delta OPL$ for two mutually orthogonal states of linear polarization, wherein said (111)-lenses are arranged with a rotation relative to each other about the lens axes in such a manner that a distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences as a function of the azimuth angle $\alpha_R$ and the aperture angle $\theta_R$ has significantly reduced values of $\Delta OPL$ in comparison to an arrangement where said (111)-lenses are not arranged with said rotation relative to each other.

2. The objective of claim 1, wherein the values of the distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences

as a function of the azimuth angle $\alpha_R$ at a fixed aperture angle $\theta_0$ vary by less than 20%, said percentage being relative to a maximum value of the distribution $\Delta OPL(\alpha_R,\theta_R)$ of the optical path differences.

3. The objective of claim 1, wherein said (111)-lenses are arranged with an angle of rotation $\gamma$ relative to each other about the lens axes, wherein a number n of (111)-lenses form a group and the angle of rotation $\gamma$ between two of the (111)-lenses of said group conforms to the equation $\gamma = \frac{120°}{n} + m \cdot 120° \pm 8°$ with m representing an integer.

4. The objective of claim 3, wherein an outermost aperture ray of the bundle of light rays has a lens-specific aperture angle $\theta_L$ within each of the (111)-lenses, and wherein said lens-specific aperture angle $\theta_L$ varies for the (111)-lenses of said group by no more than 30%, said percentage being relative to a maximum aperture angle among all (111)-lenses of said group.

5. The objective of claim 3, wherein an outermost

aperture ray of the bundle of light rays travels a lens-specific path length $RL_L$ within each of the (111)-lenses, and wherein said lens-specific path length $RL_L$ varies for the (111)-lenses of said group by no more than 30%, said percentage being relative to a maximum path length among all (111)-lenses of said group.

6. The objective of claim 3, wherein an outermost aperture ray of the bundle of light rays is subject to a lens-specific optical path difference $\Delta OPL$ within each of the (111)-lenses which is determined for non-rotated (111)-lenses, and wherein said lens-specific optical path difference $\Delta OPL$ varies for the (111)-lenses of said group by no more than 30%, said percentage being relative to a maximum optical path difference among all (111)-lenses of said group.

7. The objective of claim 3, comprising at least two groups of (111)-lenses, wherein the (111)-lenses within each of the at least two groups are rotated relative to each other.

8. A method of manufacturing objectives that

comprise at least two fluoride crystal lenses, wherein the term lenses means lenses as well as lens parts, wherein said fluoride crystal lenses are (111)-lenses each having a lens axis oriented approximately perpendicular to the {111}-planes or to crystallographic planes that are equivalent to the {111}-planes of the fluoride crystal, the method comprising the steps of:

a) determining a distribution function $\Delta OPL(\alpha_R, \theta_R)$ of optical path differences $\Delta OPL$ for light rays belonging to a bundle of rays traveling through the objective, wherein $\alpha_R$ represents an azimuth angle, $\theta_R$ represents an aperture angle, and $\Delta OPL$ represents an optical path difference of each light ray for two mutually orthogonal states of linear polarization in an image plane of the objective, and

b) arranging the (111)-lenses in rotated positions relative to each other about the lens axes in such a manner that a remaining distribution function $\Delta OPL(\alpha_R, \theta_R)$ is significantly reduced in magnitude compared to an arrangement where the (111)-lenses are not arranged in said rotated positions.

9. An objective comprising a plurality of lenses,

wherein at least two lenses consist of fluoride crystal material with a cubic lattice structure and wherein said fluoride crystal lenses are (100)-lenses each having a lens axis oriented approximately perpendicular to the {100}-planes or to crystallographic planes that are equivalent to the {100}-planes of the fluoride crystal, wherein an image point in an image plane is formed at a convergence of a bundle of light rays each of which has an azimuth angle $\alpha_R$, an aperture angle $\theta_R$ and an optical path difference $\Delta OPL$ for two mutually orthogonal states of linear polarization, wherein said (100)-lenses are arranged with a rotation relative to each other about the lens axes in such a manner that a distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences as a function of the azimuth angle $\alpha_R$ and the aperture angle $\theta_R$ has significantly reduced values of $\Delta OPL$ in comparison to an arrangement where said (100)-lenses are not arranged with said rotation relative to each other.

10. The objective of claim 9, wherein the values of the distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences as a function of the azimuth angle $\alpha_R$ at a fixed aperture angle $\theta_0$ vary by less than 20%, said percentage

being relative to a maximum values of the distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences..

11. The objective of claim 9, wherein said (100)-lenses are arranged with an angle of rotation $\gamma$ relative to each other about the lens axes, wherein a number n of (100)-lenses form a group and the angle of rotation $\gamma$ between two of the (100)-lenses of said group conforms to the equation $\gamma = \frac{90°}{n} + m \cdot 90° \pm 5°$ with m representing an integer.

12. The objective of claim 11, wherein an outermost aperture ray of the bundle of light rays has a lens-specific aperture angle $\theta_L$ within each of the (100)-lenses, and wherein said lens-specific aperture angle $\theta_L$ varies for the (100)-lenses of said group by no more than 30%, said percentage being relative to a maximum aperture angle among all (100)-lenses of said group.

13. The objective of claim 11, wherein an outermost aperture ray of the bundle of light rays travels a lens-specific path length $RL_L$ within each of the (100)-lenses, and wherein said lens-specific path length $RL_L$

varies for the (100)-lenses of said group by no more than 30%, said percentage being relative to a maximum path length among all (100)-lenses of said group.

14. The objective of claim 11, wherein an outermost aperture ray of the bundle of light rays is subject to a lens-specific optical path difference ΔOPL within each of the (100)-lenses which is determined for non-rotated (100)-lenses, and wherein said lens-specific optical path difference ΔOPL varies for the (100)-lenses of said group by no more than 30%, said percentage being relative to a maximum optical path difference among all (100)-lenses of said group.

15. The objective of claim 11, comprising at least two groups of (100)-lenses, wherein the (100)-lenses within each of the at least two groups are rotated relative to each other.

16. A method of manufacturing objectives that comprise at least two fluoride crystal lenses, wherein the term lenses means lenses as well as lens parts, wherein said fluoride crystal lenses are (100)-lenses each having a

lens axis oriented approximately perpendicular to the {100}-planes or to crystallographic planes that are equivalent to the {100}-planes of the fluoride crystal, the method comprising the steps of:

a) determining a distribution function $\Delta OPL(\alpha_R, \theta_R)$ of optical path differences $\Delta OPL$ for light rays belonging to a bundle of rays traveling through the objective, wherein $\alpha_R$ represents an azimuth angle, $\theta_R$ represents an aperture angle, and $\Delta OPL$ represents an optical path difference of each light ray for two mutually orthogonal states of linear polarization in an image plane of the objective, and

b) arranging the (100)-lenses in rotated positions relative to each other about the lens axes in such a manner that a remaining distribution function $\Delta OPL(\alpha_R, \theta_R)$ is significantly reduced in magnitude compared to an arrangement where the (100)-lenses are not arranged in said rotated positions.

17. A method of manufacturing objectives that comprises a plurality of lenses, wherein at least two lenses of at least one first group consist of fluoride crystal material with a cubic lattice structure and wherein

said fluoride crystal lenses are (111)-lenses each having a lens axis oriented approximately perpendicular to the {111}-planes or to crystallographic planes that are equivalent to the {111}-planes of the fluoride crystal,

and wherein at least two lenses of at least one second group consist of fluoride crystal material with a cubic lattice structure and wherein said fluoride crystal lenses are (100)-lenses each having a lens axis oriented approximately perpendicular to the {100}-planes or to crystallographic planes that are equivalent to the {100}-planes of the fluoride crystal, the method comprising the steps of:

a) determining a distribution function $\Delta OPL(\alpha_R, \theta_R)$ of optical path differences $\Delta OPL$ for light rays belonging to a bundle of rays traveling through the objective, wherein $\alpha_R$ represents an azimuth angle, $\theta_R$ represents an aperture angle, and $\Delta OPL$ represents an optical path difference of each light ray for two mutually orthogonal states of linear polarization in an image plane of the objective, and

b) arranging said (111)-lenses of said first group and said (100)-lenses of said second group with a rotation relative to each other about the lens axes in such a

manner that a remaining distribution function $\Delta OPL(\alpha_R, \theta_R)$ is significantly reduced in magnitude compared to an arrangement where said (111)-lenses of said first group and said (100)-lenses of said second group are not arranged with said rotation relative to each other.

18. An objective comprising at least two lenses consisting of fluoride crystal material, wherein the term lenses means lenses as well as lens parts, wherein said lenses have lens axes oriented substantially in a principal crystallographic direction, wherein an image point in an image plane (O') is formed at a convergence of a bundle of light rays each of which has an azimuth angle $\alpha_R$, an aperture angle $\theta_R$ and an optical path difference $\Delta OPL$ for two mutually orthogonal states of linear polarization, wherein the lenses are arranged with a rotation relative to each other about the lens axes in such a manner that a distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences as a function of the azimuth angle $\alpha_R$ and the aperture angle $\theta_R$ has significantly reduced values of $\Delta OPL$ in comparison to an arrangement where said lenses are likewise oriented in said principal crystallographic direction but are not arranged with said rotation relative to each other.

19. The objective of claim 18, wherein the values of the distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences as a function of the azimuth angle $\alpha_R$ at a fixed aperture angle $\theta_0$ vary by less than 30% relative to a maximum value of $\Delta OPL(\alpha_R, \theta_R)$.

20. The objective of claim 18, wherein the lens axes are oriented in the crystallographic <111>-direction or a principal crystallographic direction equivalent to the <111>-direction.

21. The objective of claim 18, wherein the lens axes are oriented in the crystallographic <100>-direction or a principal crystallographic direction equivalent to the <100>-direction.

22. The objective of claim 18, wherein the lens axes are oriented in the crystallographic <110>-direction or a principal crystallographic direction equivalent to the <110>-direction.

23. The objective of claim 18, wherein the

objective conforms to at least one of the criteria that:

- the objective has a numerical aperture NA larger than 0.7 on the image side,
- the objective has a numerical aperture NA larger than 0.8 on the image side,
- the objective is designed to operate with wavelengths shorter than 200 nanometers,
- the objective is designed to operate with wavelengths shorter than 160 nanometers,
- the objective is a refractive objective,
- the objective is a catadioptric objective with lenses and at least one mirror, and
- all lenses of the objective consist of calcium fluoride.

24. The optical element of claim 18, wherein the fluoride crystal material comprises one of a calcium fluoride crystal, a strontium fluoride crystal, and a barium fluoride crystal.

25. The objective of claim 18, comprising at least one first group of lenses whose lens axes are oriented in the crystallographic <100>-direction or a <100>-equivalent principal crystallographic direction, and further

comprising at least one second group of lenses whose lens axes are oriented in one of a first or second different crystallographic direction in relation to said first group.

26. The objective of claim 25, wherein said first different crystallographic direction consists of the <111>-direction or a <111>-equivalent principal crystallographic direction, and said second different crystallographic direction consists of the <110>-direction or a <110>-equivalent principal crystallographic direction.

27. The objective of claim 26, wherein the at least one first group causes a first distribution of optical path differences $\Delta OPL_1(\alpha_R,\theta_R)$, the at least one second group causes a second distribution of optical path differences $\Delta OPL_2(\alpha_R,\theta_R)$, and the objective causes a resultant distribution of optical path differences $\Delta OPL(\alpha_R,\theta_R)$ representing the superposition of said first and second distributions, and wherein the first distribution has a first maximum value that differs by no more than 30% from a second maximum value of the second distribution, said percentage being relative to the larger of the first and second maximum values.

28. The objective of claim 18, wherein each of the lenses has a birefringence distribution $\Delta n(\alpha_L, \theta_L)$ whose values $\Delta n$ depend on aperture angles $\theta_L$ relative to the lens axis and on azimuth angles $\alpha_L$ relative to a reference direction that is perpendicular to the lens axis, wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ has a k-fold azimuthal symmetry, wherein angles of rotation $\gamma$ are defined between the reference directions of the individual lenses, wherein a number n of lenses form a group in which the lens axes are oriented in the same or equivalent crystallographic directions, and wherein in said group the birefringence distributions $\Delta n(\alpha_L, \theta_L)$ relative to the reference directions have the same azimuthal profiles and the angle of rotation $\gamma$ between two of the lenses conforms to the equation $\gamma = \frac{360°}{k \cdot n} + m \cdot \frac{360°}{k} \pm 10°$ with m representing an integer.

29. The objective of claim 28, wherein an outermost aperture ray of the bundle of light rays has a lens-specific aperture angle $\theta_L$ within each of the lenses, and wherein said lens-specific aperture angle $\theta_L$ varies for

the lenses of the group by no more than 30%, said percentage being relative to a maximum aperture angle among all lenses of the group.

30. The objective of claim 28, wherein an outermost aperture ray of the bundle of light rays travels a lens-specific path length $RL_L$ within each of the lenses, and wherein said lens-specific path length $RL_L$ varies for the lenses of the group by no more than 30%, said percentage being relative to a maximum path length among all lenses of the group.

31. The objective of claim 28, wherein an outermost aperture ray of the bundle of light rays is subject to a lens-specific optical path difference $\Delta OPL$ within each of the lenses which is determined for non-rotated lenses, and wherein said lens-specific optical path difference $\Delta OPL$ varies for the lenses of the group by no more than 30%, said percentage being relative to a maximum optical path difference among all lenses of the group.

32. The objective of claim 28, wherein the group comprises two to four lenses.

33. The objective of claim 32, wherein the lenses of the group are arranged next to each other.

34. The objective of claim 33, wherein the lenses of the group comprise lens parts joined together by wringing.

35. The objective of claim 28, comprising at least two groups of lenses, wherein the lenses within each of the at least two groups are rotated relative to each other.

36. The objective of claim 28, wherein the lens axes are oriented in the crystallographic <111>-direction or a principal crystallographic direction equivalent to the <111>-direction, and wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ of the lenses has a threefold azimuthal symmetry.

37. The objective of claim 28, wherein the lens axes are oriented in the crystallographic <100>-direction or a principal crystallographic direction equivalent to the <100>-direction, and wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ of the lenses has a fourfold azimuthal symmetry.

38. The objective of claim 28, wherein the lens axes are oriented in the crystallographic <110>-direction or a principal crystallographic direction equivalent to the <110>-direction, and wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ of the lenses has a twofold azimuthal symmetry.

39. The objective of claim 28, wherein the objective conforms to at least one of the criteria that:

- the objective has a numerical aperture NA larger than 0.7 on the image side,
- the objective has a numerical aperture NA larger than 0.8 on the image side,
- the objective is designed to operate with wavelengths shorter than 200 nanometers,
- the objective is designed to operate with wavelengths shorter than 160 nanometers,
- the objective is a refractive objective,
- the objective is a catadioptric objective with lenses and at least one mirror, and
- all lenses of the objective consist of calcium fluoride.

40. The objective of claim 28, comprising at least

one first group of lenses whose lens axes are oriented in the crystallographic <100>-direction or a <100>-equivalent principal crystallographic direction, and further comprising at least one second group of lenses whose lens axes are oriented in one of a first or second different crystallographic direction in relation to said first group.

41. The objective of claim 40, wherein said first different crystallographic direction consists of the <111>-direction or a <111>-equivalent principal crystallographic direction, and said second different crystallographic direction consists of the <110>-direction or a <110>-equivalent principal crystallographic direction.

42. The objective of claim 41, wherein the at least one first group causes a first distribution of optical path differences $\Delta OPL_1(\alpha_R,\theta_R)$, the at least one second group causes a second distribution of optical path differences $\Delta OPL_2(\alpha_R,\theta_R)$, and the objective causes a resultant distribution of optical path differences $\Delta OPL(\alpha_R,\theta_R)$ representing the superposition of said first and second distributions, and wherein the first distribution has a first maximum value that differs by no more than 30%

from a second maximum value of the second distribution, said percentage being relative to the larger of the first and second maximum values.

43. The objective of claim 18, wherein each of the lenses has a birefringence distribution $\Delta n(\alpha_L, \theta_L)$ whose values $\Delta n$ depend on aperture angles $\theta_L$ relative to the lens axis and on azimuth angles $\alpha_L$ relative to a reference direction that is perpendicular to the lens axis, wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ has a k-fold azimuthal symmetry, wherein angles of rotation $\gamma$ are defined between the reference directions of the individual lenses, wherein a number n of subgroups of lenses form a group in which the lens axes are oriented in the same or equivalent crystallographic directions, and wherein in said group the birefringence distributions $\Delta n(\alpha_L, \theta_L)$ relative to the reference directions have the same azimuthal profiles, wherein each of the n subgroups comprises at least one lens, wherein the angle of rotation $\gamma$ between any two of the lenses within one of the subgroups conforms to the equation $\gamma = 1 \cdot \frac{360°}{k} \pm 10°$ and the angle of rotation $\gamma$ between two lenses from different subgroups conforms to the equation

$\gamma = \frac{360°}{k \cdot n} + m \cdot \frac{360°}{k} \pm 10°$ with l and m representing integer numbers.

44. The objective of claim 43, comprising at least two groups of lenses, wherein the lenses within each of the at least two groups are rotated relative to each other.

45. The objective of claim 43, wherein the lens axes are oriented in the crystallographic <111>-direction or a principal crystallographic direction equivalent to the <111>-direction, and wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ of the lenses has a threefold azimuthal symmetry.

46. The objective of claim 43, wherein the lens axes are oriented in the crystallographic <100>-direction or a principal crystallographic direction equivalent to the <100>-direction, and wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ of the lenses has a fourfold azimuthal symmetry.

47. The objective of claim 43, wherein the lens axes are oriented in the crystallographic <110>-direction or a principal crystallographic direction equivalent to the

<110>-direction, and wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ of the lenses has a twofold azimuthal symmetry.

48. The objective of claim 43, wherein the objective conforms to at least one of the criteria that:

- the objective has a numerical aperture NA larger than 0.7 on the image side,
- the objective has a numerical aperture NA larger than 0.8 on the image side,
- the objective is designed to operate with wavelengths shorter than 200 nanometers,
- the objective is designed to operate with wavelengths shorter than 160 nanometers,
- the objective is a refractive objective,
- the objective is a catadioptric objective with lenses and at least one mirror, and
- all lenses of the objective consist of calcium fluoride.

49. The objective of claim 43, comprising at least one first group of lenses whose lens axes are oriented in the crystallographic <100>-direction or a <100>-equivalent principal crystallographic direction, and further comprising at least one second group of lenses whose lens

axes are oriented in one of a first or second different crystallographic direction in relation to said first group.

50. The objective of claim 49, wherein said first different crystallographic direction consists of the <111>-direction or a <111>-equivalent principal crystallographic direction, and said second different crystallographic direction consists of the <110>-direction or a <110>-equivalent principal crystallographic direction.

51. The objective of claim 50, wherein the at least one first group causes a first distribution of optical path differences $\Delta OPL_1(\alpha_R, \theta_R)$, the at least one second group causes a second distribution of optical path differences $\Delta OPL_2(\alpha_R, \theta_R)$, and the objective causes a resultant distribution of optical path differences $\Delta OPL(\alpha_R, \theta_R)$ representing the superposition of said first and second distributions, and wherein the first distribution has a first maximum value that differs by no more than 30% from a second maximum value of the second distribution, said percentage being relative to the larger of the first and second maximum values.

52. A microlithography projection system, comprising an illumination system and further comprising the objective of claim 18, wherein the objective projects an image of a mask carrying a structure onto a light-sensitive substrate.

53. A method of manufacturing semiconductor components comprising a step in which the microlithography projection system of claim 52 is used.

54. A method of manufacturing objectives that comprise at least two fluoride crystal lenses, wherein the term lenses means lenses as well as lens parts, wherein said lenses have lens axes and each of said lens axes is oriented substantially in a principal crystallographic direction, the method comprising the steps of:

a) determining a distribution function $\Delta OPL(\alpha_R, \theta_R)$ of optical path differences $\Delta OPL$ for light rays belonging to a bundle of rays traveling through the objective, wherein $\alpha_R$ represents an azimuth angle, $\theta_R$ represents an aperture angle, and $\Delta OPL$ represents an optical path difference of each light ray for two mutually orthogonal states of linear polarization in an image

plane of the objective, and

b) arranging the lenses in rotated positions relative to each other about the lens axes in such a manner that a remaining distribution function $\Delta OPL(\alpha_R, \theta_R)$ is significantly reduced in magnitude compared to an arrangement where each lens is oriented likewise in said principal crystallographic direction but where the lenses are not arranged in said rotated positions.

55. The method of claim 54, wherein the objective comprises at least one first group of lenses whose lens axes are oriented in the crystallographic <100>-direction or a <100>-equivalent principal crystallographic direction, and at least one second group of lenses whose lens axes are oriented in the crystallographic <111>-direction or a <111>-equivalent principal crystallographic direction.

56. The method of claim 54, wherein the objective comprises at least one first group of lenses whose lens axes are oriented in the crystallographic <100>-direction or a <100>-equivalent principal crystallographic direction, and at least one second group of lenses whose lens axes are oriented in the crystallographic <110>-direction or a

<110>-equivalent principal crystallographic direction.

57. The method of claim 54, further comprising the steps of

c) based on said remaining distribution function $\Delta OPL(\alpha_R, \theta_R)$ of step b), determining an effective birefringence distribution of a compensation coating for a further reduction of the optical path differences $\Delta OPL$, wherein the compensation coating has effective birefringence values dependent on azimuth angles $\alpha_F$ measured relative to a reference direction that is perpendicular to an element axis of an optical element to be coated and dependent on aperture angles $\theta_F$ measured relative to the element axis;

d) based on said effective birefringence distribution, determining a design specification for the compensation coating; and

e) applying the compensation coating to the optical element of the objective.

58. The objective of claim 18, comprising a plurality of optical elements that includes said lenses, wherein the optical elements have optical surfaces and at

least one of said optical surfaces is coated with a compensation coating, said compensation coating being configured in such a way that the distribution of optical path differences $\Delta OPL(\alpha_R, \theta_R)$ for a bundle of rays as a function of the azimuth angle $\alpha_R$ and the aperture angle $\theta_R$ is significantly reduced in magnitude in comparison to an objective without the compensation coating.

59. The objective of claim 58, wherein the optical element with the compensation coating has an element axis and wherein the compensation coating has an effective birefringence distribution with effective birefringence values being a function of an azimuth angle $\alpha_F$ and an aperture angle $\theta_F$, said azimuth angle being measured relative to a reference direction that is perpendicular to the element axis and said aperture angle being measured relative to the element axis.

60. The objective of claim 59, wherein the effective birefringence value of the compensation coating is approximately zero for an aperture angle of $\theta_F=0°$.

61. The objective of claim 59, wherein the

effective birefringence value of the compensation coating depends primarily on the aperture angle $\theta_F$ alone.

62. The objective of claim 58, wherein the optical element with the compensation coating is one of the at least two fluoride crystal lenses, and wherein the element axis is the lens axis of the fluoride crystal lens with the compensation coating.

63. The objective of claim 58, wherein more than one optical element carries the compensation coating.

64. The objective of claim 58, wherein all of the optical elements carry the compensation coatings.

65. An objective comprising a plurality of optical elements with optical surfaces, said optical elements including lenses of a fluoride crystal material with a cubic lattice structure, wherein the term lenses means lenses as well as lens parts, wherein an image point in an image plane is formed at a convergence of a bundle of light rays each of which has an optical path difference ΔOPL for two mutually orthogonal states of linear polarization, and

wherein at least one of the optical surfaces is coated with a compensation coating, said compensation coating being configured in such a way that the optical path differences ΔOPL that are caused by the fluoride crystal lenses are significantly reduced in magnitude in comparison to an objective without the compensation coating.

66 . The objective of claim 65, wherein the light rays have wavelengths shorter than 160nm.

67. An objective comprising a plurality of optical elements with optical surfaces, said optical elements including fluoride crystal lenses, wherein the term lenses means lenses as well as lens parts, wherein an image point in an image plane (O') is formed at a convergence of a bundle of light rays each of which has an optical path difference ΔOPL for two mutually orthogonal states of linear polarization, and wherein at least one of the optical surfaces is coated with a compensation coating, said compensation coating being configured in such a way that the optical path differences ΔOPL are significantly reduced in magnitude in comparison to an objective without the compensation coating.

68. The objective of claim 67, wherein the optical element with the compensation coating has an element axis and wherein the compensation coating has an effective birefringence distribution with effective birefringence values being a function of an azimuth angle $\alpha_F$ and an aperture angle $\theta_F$, said azimuth angle being measured relative to a reference direction that is perpendicular to the element axis and said aperture angle being measured relative to the element axis.

69. The objective of claim 68, wherein the value of the effective birefringence distribution of the compensation coating is approximately zero for an aperture angle of $\theta_F=0°$.

70. The objective of claim 68, wherein the effective birefringence value of the compensation coating depends primarily on the aperture angle $\theta_F$ alone.

71. The objective of claim 67, wherein the optical element with the compensation coating is an interchangeable element.

72. The objective of claim 67, wherein at least two of the optical elements are fluoride crystal lenses and have lens axes oriented in a principal crystallographic direction or in equivalent principal crystallographic directions, and wherein the lenses are arranged relative to each other with a rotation relative to the lens axes in such a manner that a distribution function $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences of the bundle of rays as a function of the azimuth angle $\alpha_R$ and the aperture angle $\theta_R$ has significantly smaller values in comparison to lenses that likewise have lens axes oriented in said principal crystallographic direction or equivalent principal crystallographic directions but are not arranged with said rotation relative to each other.

73. The objective of claim 72, wherein the optical path differences $\Delta OPL$ as a function of the azimuth angle $\alpha_R$ at a fixed aperture angle $\theta_0$ vary by less than 30% relative to a maximum value of the optical path differences.

74. The objective of claim 72, wherein each of the lenses has a birefringence distribution $\Delta n(\alpha_L, \theta_L)$ whose

values $\Delta n$ depend on azimuth angles $\alpha_L$ relative to a reference direction that is perpendicular to the lens axis and on aperture angles $\theta_L$ relative to the lens axis, wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ has a k-fold azimuthal symmetry, wherein angles of rotation $\gamma$ are defined between the reference directions of the individual lenses, wherein a number n of lenses form a group in which the lens axes are oriented in the same or equivalent crystallographic directions, and wherein in said group the birefringence distributions $\Delta n(\alpha_L, \theta_L)$ relative to the reference directions have the same azimuthal profiles and the angle of rotation $\gamma$ between two of the lenses conforms to the equation $\gamma = \frac{360°}{k \cdot n} + m \cdot \frac{360°}{k} \pm 10°$ with m representing an integer.

75. The objective of claim 72, wherein each of the lenses has a birefringence distribution $\Delta n(\alpha_L, \theta_L)$ whose values $\Delta n$ depend on aperture angles $\theta_L$ relative to the lens axes and on azimuth angles $\alpha_L$ relative to a reference direction that is perpendicular to the lens axis, wherein the birefringence distribution $\Delta n(\alpha_L, \theta_L)$ has a k-fold

azimuthal symmetry, wherein angles of rotation $\gamma$ are defined between the reference directions of the individual lenses, wherein a number n of subgroups of lenses form a group in which the lens axes are oriented in the same or equivalent crystallographic directions, and wherein in said group the birefringence distributions $\Delta n(\alpha_L, \theta_L)$ relative to the reference directions have the same azimuthal profiles, wherein each of the n subgroups comprises at least one lens, wherein the angle of rotation $\gamma$ between any two of the lenses within one of the subgroups conforms to the equation $\gamma = l \cdot \frac{360°}{k} \pm 10°$ and the angle of rotation $\gamma$ between two lenses from different subgroups conforms to the equation $\gamma = \frac{360°}{k \cdot n} + m \cdot \frac{360°}{k} \pm 10°$ with l and m representing integer numbers.

76. The objective of claim 72, wherein the optical element with the compensation coating is one of the fluoride crystal lenses, and wherein the element axis is the lens axis of the fluoride crystal lens.

77. The objective of claim 67, wherein more than one optical element is coated with a compensation coating.

78. The objective of claim 67, wherein the objective conforms to at least one of the criteria that:

- the objective has a numerical aperture NA larger than 0.7 on the image side,
- the objective has a numerical aperture NA larger than 0.8 on the image side,
- the objective is designed to operate with wavelengths shorter than 200 nanometers,
- the objective is designed to operate with wavelengths shorter than 160 nanometers,
- the objective is a refractive objective,
- the objective is a catadioptric objective with lenses and at least one mirror, and
- all lenses of the objective consist of calcium fluoride.

79. A microlithography projection system, comprising an illumination system and further comprising the objective of claim 67, wherein the objective projects an image of a mask carrying a structure onto a light-sensitive substrate.

80. A method of manufacturing semiconductor

components comprising a step in which the microlithography projection system of claim 79 is used.

81. A method of compensating effects caused by birefringence in an objective that has a plurality of optical elements with optical surfaces, including fluoride crystal lenses, wherein at least one of said optical elements is an interchangeable element, wherein an image point in an image plane is formed at a convergence of a bundle of light rays, each of said rays having an azimuth angle $\alpha_R$, an aperture angle $\theta_R$ and an optical path difference $\Delta OPL$ for two mutually orthogonal states of linear polarization, and wherein said method comprises the steps of

a) determining a distribution of optical path differences $\Delta OPL(\alpha_R, \theta_R)$;

b) based on said distribution $\Delta OPL(\alpha_R, \theta_R)$, determining an effective birefringence distribution of a compensation coating to be applied to the interchangeable element, wherein the compensation coating has effective birefringence values dependent on azimuth angles $\alpha_F$ measured relative to a reference direction that is perpendicular to an element axis of the optical element

and dependent on aperture angles $\theta_F$ measured relative to the element axis;

c) taking the optical element out of the objective;

d) applying the compensation coating to the interchangeable element; and

e) reinstalling the optical element in the objective.

82. An objective comprising at least two lenses consisting of fluoride crystal material, wherein the term lenses means lenses as well as lens parts, wherein said lenses have lens axes oriented substantially in a principal crystallographic direction, wherein an image point in an image plane is formed at a convergence of a bundle of light rays each of which has an azimuth angle $\alpha_R$, an aperture angle $\theta_R$ and an optical path difference $\Delta OPL$ for two mutually orthogonal states of linear polarization, wherein the lenses are arranged with a rotation relative to each other about the lens axes in such a manner that a distribution $\Delta OPL(\alpha_R, \theta_R)$ of the optical path differences as a function of the azimuth angle $\alpha_R$ and the aperture angle $\theta_R$ has significantly reduced values of $\Delta OPL$ in comparison to an arrangement where said lenses are likewise oriented in said principal crystallographic direction but are not

arranged with said rotation relative to each other, wherein said objective comprises a composite lens in which a plurality of plates consisting of crystal material are seamlessly joined together, said plates being crystallographically oriented at mutually rotated positions relative to a normal axis of each plate.

83. An objective comprising a plurality of optical elements with optical surfaces, said optical elements including fluoride crystal lenses, wherein the term lenses means lenses as well as lens parts, wherein an image point in an image plane is formed at a convergence of a bundle of light rays each of which has an optical path difference $\Delta OPL$ for two mutually orthogonal states of linear polarization, and wherein at least one of the optical surfaces is coated with a compensation coating, said compensation coating being configured in such a way that the optical path differences $\Delta OPL$ are significantly reduced in magnitude in comparison to an objective without the compensation coating, wherein said objective comprises a composite lens in which a plurality of plates consisting of crystal material are seamlessly joined together, said plates being crystallographically oriented at mutually rotated positions relative to a normal axis of each plate.